DI. 954

EVALUATION OF LX-17

MADE FROM WATER-AMINATED TATB

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Dist. Category UC-45

MASTER

OCTOBER 1982

Process Development

Endeavor No. 213

Mason & Hanger-Silas Mason Co. Inc
Panther Plant

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EVALUATION OF LX-17 MADE FROM WATER-AMINATED TATB**A. Gordon Osborn****OCTOBER 1982****Process Development
Endeavor No. 213****ABSTRACT**

Water-aminated TATB was formulated into LX-17 at both Pantex and Holston. Mechanical properties, growth, pressed density, corner turning and gap sensitivity properties were compared. Mechanical properties, corner turning and gap sensitivity were similar to those of LX-17 made from dry-aminated TATB. Permanent expansion resulting from thermal aging may be slightly greater than that of LX-17 with dry-aminated TATB.

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INTRODUCTION

TATB made by the water amination process contains less inorganic chlorine impurities than TATB made by the standard dry amination process. The chlorine content is reduced from a normal 0.5% to less than 0.2%. The water amination process differs from the dry amination process in that 10 volume percent water is added to the toluene reaction solvent. The reaction temperature is reduced from 150 to 125 C as gaseous ammonia is introduced to the reaction ullage because of the increased vapor pressure. The chlorine content is less because the NH_4Cl (a byproduct of the amination reaction) normally trapped in TATB crystals is dissolved in the water. Particle size is somewhat less than that from the dry amination process. These changes yield an improved product.

Water-aminated TATB was processed into a plastic bonded explosive (LX-17) on a small scale in a 10-litre reactor prior to scale-up in a 300-gallon kettle at Pantex and a 500-gallon reactor at Holston.

DISCUSSION

Hercules water-aminated TATB (lot-374)^a was formulated into an 88-kg batch of LX-17 (No. 1337-145-01) in a 300-gallon kettle using a standard slurry procedure described below. This batch was then compared to two lots of LX-17 made at Holston, one from the same lot of Hercules water-aminated TATB^a and the other from Hercules lot 350R^b.

A standard formulation procedure was used to produce both the 1-kg and 88-kg batches. The water-aminated TATB which is shipped with up to 20% water was analyzed to determine moisture content. The TATB on a dry weight basis was mixed with twice its weight of water in the reactor and slurried for 10 minutes at 60 C. A lacquer consisting of 13.5 to 14.5% by weight Kel-F 800 dissolved in ethyl acetate was then added to the reactor. For the 88-kg LX-17 batch, 6.6 kg of Kel-F 800 was contained in the lacquer. Following the addition of the lacquer the mixture was reheated to 60 C and slurried for 10 minutes. The mixture was then quenched by adding 3.4 kg water per kg TATB over a 30-minute period while maintaining 60 C and regulating the agitation rate to produce granules in the 1-2 mm range. The slurry was aged an additional 30 minutes at 60 C with regulated agitation. The heat to the

^aHercules TATB Lot No. 09-23-81-TATB-374; Holston LX-17 Lot No. 82A000EC91

^bHercules TATB Lot No. 08-26-81-TATB-350R; Holston LX-17 Lot No. 82A000E090

reactor was then increased to distill off the ethyl acetate until the temperature reached 82-85 C. The vessel was then emptied, the granules separated from the liquid and the granules washed with tap water. The granules were placed in trays to a depth of 6 cm or less and dried at 120 C for 20 hours.

The water-aminated TATB used in two of the 1-kg batches was oven dried prior to the formulation process.

The 500-gallon Holston process is similar to that described above with the following exceptions. Holston uses a 12.5% by weight Kel-F 800 solution in water-saturated ethyl acetate as the lacquer. They use 4.5-kg water per kg TATB for quenching rather than 3.4-kg water. Holston ages the slurry for 60 minutes and distills the ethyl acetate until a temperature of 100 C is reached. Holston dries the LX-17 granules at 90 C for 12 hours in a hot air bed dryer in trays which are packed to 15 cm thickness.

Lot sizes, compositions, particle sizes and moisture contents are given in Table I. LLNL Blend 36, a 792-kg lot of LX-17 (No. 1117-145-01), made previously from Hercules water-aminated TATB, is included in the table for comparison. LLNL Blend 36 is a blend of five lots of LX-17; BX-1, -2, -4, -5, and -6^c. BX-1 which comprises about 15% of B-36 was made from TATB aminated in 5% percent water in the reaction solvent as contrasted to the other water-aminated material which was made in a 10% water containing solvent. Chlorine content for BX-1 was in the same range as the others. Also B-36 was made during the development of the formulation procedure for water-aminated TATB and the individual batch sizes varied from 55 to 118-kg and several batches required reworking.

TATB particle size distributions before and after formulation of lot 374 are shown in Fig. 1, and for TATB lot 350R in Fig. 2. Fig. 2 also contains the particle size distribution for LLNL Blend 36 after formulation. Fig. 3 contains the particle size distributions for the four small batches after formulation.

The gap sensitivity and the corner turning test-firing performance of the large LX-17 lots are compared in Table II. The 1.0-inch gap test(1) was developed for TATB PBX evaluation.

The corner turning test is a modification of the Los Alamos corner turning test. The effects of density on gap and corner turning are shown in Fig. 4.

^cData Package for LLNL Blend 36, August 1981

(1) Paul E. Kramer, "TATB Sensitivity Testing," MHSMP-74-35T, dated July - September 1974.

The physical properties test data are summarized in Table III. Included are tensile, compression and diametric disc strength, and growth, or permanent dimension expansion resulting from thermal aging. The growth parts were subjected to 30 thermal cycles from ambient to +74 C to -54 C and back to ambient in a 24-hour period. The physical strength and growth curves are shown in Fig. 5 through Fig. 11 for the large LX-17 lots. The diametric disc data from the 1-kg batches are shown in Fig. 12.

CONCLUSIONS

The formulation of water-aminated TATB into LX-17 was straightforward. No unusual problems occurred either at Pantex or Holston. The TATB particle size was reduced a nominal amount as a result of the slurry process. The particle size reduction at both Pantex and Holston appears to be similar.

Both the gap sensitivity test and corner turning appear to be affected by pressed density as shown in Fig. 4. The gap sensitivities ranging from 1.52 to 2.62 mm, are typical of that obtained from LX-17 made with dry-aminated TATB. Also, corner turning distance appears to be in the range acceptable for LX-17, although LX-17 with water-aminated TATB can be pressed to a higher density.

Generally, the physical properties are typical of those normally obtained with LX-17. The pressed densities of the Pantex-formulated LX-17 lots were consistently several milligrams less than those from Holston-formulated LX-17. However, other physical data compare relatively well, with similar strength and growth values. Preliminary indications are that the growth may be slightly greater than that of LX-17 from dry-aminated TATB.

Table I. Summary of LX-17 Lots

TATB Lot No.	LX-17 Lot No.	Lot Size (kg)	Composition (% Kel-F)	TATB Particle Size ^d			LX-17 Karl Fischer (% Moisture)
				(% < 44)	(% < 20)	Median (μ m)	
09-23-81-TATB-374 ^a	PX-1337-145-01	88.0	7.5	82.0	60.7	16.3	0.12
09-23-81-TATB-374 ^a	HOL-82A-000E091	147.0	7.8	81.1	61.7	15.8	0.12
08-26-81-TATB-350R ^b	HOL-82A-000E090	281.0	8.0	85.9	51.5	19.0	0.10
HERCULES-LLNL BLEND ^c	PX-1117-145-01	792.0	7.3	77.5	49.3	20.9	0.05
08-26-81-TATB-350R ^b	PX-1317-145-01	1.0	7.5	81.9	45.3	22.9	0.33
08-26-81-TATB-350R ^{bc}	PX-1288-145-01	1.0	7.3	74.6	36.0	29.7	0.20
09-23-81-TATB-374 ^a	PX-1316-145-01	1.0	7.6	78.7	56.0	17.1	0.10
09-23-81-TATB-374 ^{ac}	PX-1287-145-01	1.0	7.6	79.3	55.5	17.4	0.06

^aTATB particle size prior to formulation: < 44 μ m--64.3%; < 20 μ m--41.3%; median = 28.6 μ m

^bTATB particle size prior to formulation: < 44 μ m--65.3%; < 20 μ m--31.0%; median = 32.4 μ m

^cTATB dried prior to formulating into LX-17

^dExtracted from LX-17

Table II. Summary of Gap Sensitivity and Corner Turning Characteristics

TATB Lot No.	LX-17 Lot No.	Lot Size (kg)	Gap Test			Corner Turning Test		
			Density (Mg/m ³)	% TMD	Gap (mm)	Density (Mg/m ³)	% TMD	Distance (mm)
09-23-81-TATB-374	PX-1337-145-01	88.0	1.898	97.6	2.62	1.900	97.7	19.1
09-23-81-TATB-374	HOL-82A000E901	147.0	1.911	98.3	1.52	1.911	98.3	30.4
08-26-81-TATB-350R	HOL-82A000E090	281.0	1.906	98.0	1.85	1.908	98.1	25.7
HERC-LLL Blend 36	PX-1117-145-01	792.0	1.911	98.3	1.60	1.915	98.5	42.0

Table III. Physical Properties Summary

TATB Lot No. ^a	LX-17 Lot No. ^a	LX-17 Lot Size (kg)	Density ^b (Mg/m ³)	%TMD	Diametric Disc Ultimate		Compression Ultimate		Rupture	Tensile Ultimate		Growth	
					Stress (MPa)	Strain (%)	Stress (MPa)	Strain (%)	Strain (%)	Stress (MPa)	Strain (%)	Height (mm/m)	Diameter (mm/m)
374	1337	88.0	1.897	97.6	4.24	0.41	23.02	2.61	8.09	9.45	0.42	3.6	4.1
374	E091	147.0	1.910	98.2	4.94	0.46	23.76	2.73	6.74	10.62	0.52	5.4	5.3
350R	E090	147.0	1.906	98.0	4.68	0.38	23.33	2.59	6.90	10.06	0.46	5.4	5.5
LLL B36	1117	792.0	1.910	98.3	4.58	0.43	23.06	2.63	3.23	10.11	0.43	4.2	4.2
350R	1317	1.0	1.896	97.5	4.43	0.36							
350RC ^c	1288	1.0	1.894	97.4	4.54	0.42							
374	1316	1.0	1.895	97.5	4.58	0.44							
374 ^c	1287	1.0	1.902	97.8	4.78	0.49							

^aFor full lot number see Table I^bAverage density of physical properties specimens^cTATB dried prior to being made into LX-17

Fig. 1A. Hercules Synthesized TATB Lot 374

Fig. 1B. Holston Formulated LX-17-0 Lot E-091 (147 kg)
(TATB Lot 374)

Fig 1C. Pantex Formulated LX-17-0 Lot 1337 (88 kg)
(TATB Lot 374)

Fig. 2A. Hercules Synthesized TATB Lot 350R

Fig. 2B. Holston Formulated LX-17-0 Lot 090 (281 kg)
TATB Lot 350R

Fig. 2C. Pantex Formulated LX-17-0 Lot 1117 792 kg Blend
LLL Blend 36

Fig. 3A. Pantex Formulated LX-17-0 Lot 1317 (1 kg)
TATB Lot 350 R

Fig. 3B. Pantex Formulated LX-17-0 Lot 1288 (1 kg)
TATB Lot 350 R

Fig. 3C. Pantex Formulated LX-17-0 Lot 1316 (1 kg)
TATB Lot 374

Fig. 3D. Pantex Formulated LX-17-0 Lot 1287 (1 kg)
TATB Lot 374

Fig. 4. LX-17 Firing Performance Test

Fig. 5. LX-17 Small Tensile Test
(Water-Aminated TATB)

Fig. 6. LX-17 Compression Test (Water-Aminated TATB)

Fig. 7. LX-17 Diametric Disc Test (Water-Aminated TATB)

Fig. 8. LX-17 Lot 1337 Growth Test

Fig. 9. LX-17 Lot E091 Growth Test

Fig. 10. LX-17 Lot E090 Growth Test

Fig. 11. LX-17 Lot 1117 Growth Test Blend 36

Fig. 12. LX-17 Diametric Disc Test (1 kg Batches)
Water-Aminated TATB

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